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**Minimum Operational Performance
Standards (MOPS)
For Airborne Separation Assistance System (ASAS)**

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FOREWORD

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1 PURPOSE AND SCOPE

1.1 Introduction

This document contains Minimum Operational Performance Standards for *Airborne Separation Assistance Systems*.¹ These standards specify system characteristics that should be useful to designers, manufacturers, installers and users of the equipment.

Compliance with these standards is recommended as one means of assuring that the equipment will perform its intended function(s) satisfactorily under all conditions normally encountered in routine aeronautical operation. Any regulatory application of this document is the sole responsibility of appropriate governmental agencies.

Section 1 of this document provides information needed to understand the rationale for equipment characteristics and requirements stated in the remaining sections. It describes typical equipment operations and operation goals, as envisioned by the members of Special Committee 186, and establishes the basis for the standards stated in Sections 2 through 3. Definitions and assumptions essential to proper understanding of this document are also provided in this section.

Section 2 contains the Minimum Performance Standards for the equipment. These standards specify the required performance under standard environmental conditions. Also included are recommended bench test procedures necessary to demonstrate equipment compliance with the stated minimum requirements.

Section 3 describes the performance required of installed equipment. Tests for the installed equipment are included when performance cannot be adequately determined through bench testing.

Section 4 describes the operational performance characteristics for equipment installations and defines conditions that will assure the equipment user that operations can be conducted safely and reliably in the expected operational environment.

This document considers functional requirements consisting of: Surveillance Transmit Processing (STP), airborne surveillance and separation assurance processing (ASSAP), and cockpit display of traffic information (CDTI) as described in the ASA MASPS, DO-???. Operational performance standards for functions or components that refer to equipment capabilities that exceed the stated minimum requirements are identified as optional features.

The word “function” as used in this document includes all components and units necessary for the system to properly perform its intended function(s). For example, the “function” may be implemented in hardware or software, as appropriate, and the function may be partitioned within the hardware and software as is most convenient for a particular implementation.

If the functional implementation includes a computer software package, the guidelines contained in RTCA Document No. DO-178B, *Software Consideration in Airborne Systems and Equipment Certification*, should be considered.

¹ Bold-italic text in this Guide pertains to the specific equipment described in the MOPS and provides guidance on what type of text needs to be developed.

1.2 System Overview

Describe the system, in general terms, to establish a basic understanding that will support the information to follow in this section. It is important that the Committee define the equipment being specified in the context of the overall system. In preparing material for paragraph 1.2, 1.3 and 1.4, the Committee should consider that a system may comprise airborne and ground elements each having hardware, software, procedural, etc., aspects.

1.3 Operational Application(s)

Add Words referring to ASA MASPS.

1.4 Intended Function

Add words referring to ASA MASPS.

1.5 Operational Goals

Add words referring to ASA MASPS.

1.6 Assumptions

Describe the assumptions made, because of inadequate or non-existent information, having a bearing on stated requirements. Where possible, include a statement regarding the sensitivity of each assumption.

1.7 Test Procedures

The test procedures specified in this document are intended to be used as one means of demonstrating compliance with the performance requirement. Although specific test procedures are cited, it is recognized that other methods may be preferred. These alternate procedures may be used if they provide at least equivalent information. In such cases, the procedures cited herein should be used as one criterion in evaluating the acceptability of the alternate procedures.

The order of tests specified suggests that the equipment be subjected to a succession of tests as it moves from design, and design qualification, into operational use. For example, compliance with the requirements of Section 2 shall have been demonstrated as a precondition to satisfactory completion of the installed system tests of Section 3.

a. Environmental Tests

Environmental test requirements are specified in Subsection 2.3. The procedures and their associated limits are intended to provide a laboratory means of determining the electrical and mechanical performance of the equipment under environmental conditions expected to be encountered in actual operations.

Unless otherwise specified, the environmental conditions and test procedures contained in RTCA Document No. DO-160C, *Environmental Conditions and Test Procedures for Airborne Equipment*, will be used to demonstrate equipment compliance.

b. Bench Tests

Bench test procedures are specified in Subsection 2.4. These tests provide a laboratory means of demonstrating compliance with the requirements of Subsection 2.2. Test results may be used by equipment manufacturers as design guidance, for monitoring manufacturing compliance and, in certain cases, for obtaining formal approval of equipment design.

c. Installed Equipment Tests

The installed equipment test procedures and their associated limits are specified in Section 3. Although bench and environmental test procedures are not included in the installed equipment test, their successful completion is a precondition to completion of the installed test. In certain instances, however, installed equipment test may be used in lieu of bench test simulation of such factors as power supply characteristics, interference from or to other equipment installed on the aircraft, etc. Installed tests are normally performed under two conditions:

1. With the aircraft on the ground and using simulated or operational system inputs.
2. With the aircraft in flight using operational system inputs appropriate to the equipment under test.

Test results may be used to demonstrate functional performance in the intended operational environment.

d. Operational Tests

The operational tests are specified in Section 4. These test procedures and their associated limits are intended to be conducted by operating personnel as one means of ensuring that the equipment is functioning properly and can be reliably used for its intended function(s).

1.8

Definition of Terms

Define those terms used in this document that could have multiple meanings or are not normally used.

2 Equipment Performance Requirements and Test Procedures

2.1 General Requirements

General equipment requirements need not be tested in the test procedure subsection. If a requirement needs to be tested, it is not a general requirement and should be included in paragraph 2.2.

2.1.1 Airworthiness

In the design and manufacture of the equipment, the manufacturer shall provide for installation so as not to impair the airworthiness of the aircraft.

2.1.2 Intended Function

The equipment shall perform its intended function(s), as defined by the manufacturer, and its proper use shall not create a hazard to other users of the National Airspace System.

2.1.3 Federal Communications Commission Rules

All equipment shall comply with the applicable rules of the Federal Communication Commission.

2.1.4 Fire Protection

All materials used shall be self-extinguishing except for small parts (such as knobs, fasteners, seals, grommets and small electrical parts) that would not contribute significantly to the propagation of a fire.

Note: *One means of showing compliance is contained in Federal Aviation Regulations (FAR), Part 25, Appendix F.*

2.1.5 Operation of Controls

The equipment shall be designed so that controls intended for use during flight cannot be operated in any position, combination or sequence that would result in a condition detrimental to the reliability of the equipment or operation of the aircraft.

2.1.6 Accessibility of Controls

Controls that do not require adjustment during flight shall not be readily accessible to flight personnel.

2.1.7 Effects of Test

The equipment shall be designed so that the application of specified test procedures shall not be detrimental to equipment performance following the application of the tests, except as specifically allowed.

2.1.8 Design Assurance

Reference back to the ASA MASPS for design assurance requirements. This paragraph will discuss the appropriate design assurance level(s) that would be expected as a result of the function definitions and failure categorization(s) contained in Section 1 of the document. This should be based upon the criteria of AC 23.1309 and 25.1309-1b. This paragraph should address both misleading information and the loss of the function. MOPS should point to the latest revision of the RTCA Document No. DO-178() document as a method of establishing the appropriate software levels. A specific software level should not be established in the MOPS since the definitions of the levels could change in RTCA Document DO-178() after the MOPS is issued. The MOPS under development should also point to any hardware or system design assurance standards that are in effect at the time of writing (i.e., SAE ARP-4754).

2.2 Airborne Surveillance and Separation Assistance Processing (ASSAP) Subsystem Requirements

2.2.1 System interfaces to ASSAP (R3.214 – R3.217)

2.2.2 Own-ship ASA Capability Level (ACL) Determination (DO-289 R2.1, R2.2, R2.3, R2.6 - R2.21, R3.200)

2.2.3 Surveillance Processing

2.2.3.1 Source Level Tracking (Association/Candidate windows, ADS/B to ADS/B TIS-B/TIS-B tracking) (R3.169, 3.170, 3.171, 3.177, 3.178)

2.2.3.1.1 Track State Estimation (R3.174, , 3.176)

2.2.3.1.1.1 Track integrity determination

2.2.3.1.1.2 Track accuracy determination

2.2.3.1.1.3 Determination of Track Velocity from Position-Only Data (R3.189)

2.2.3.2 Track / Track Correlation (Cross Referencing between Sources) (R3.172, R3.173)**2.2.3.2.1 Correlation of ADS-B targets from Multiple Links (R3.185)****2.2.3.2.2 Correlation between TIS-B Tracks and ADS-B Tracks (R3.183, R3.184)****2.2.3.2.3 Correlation of TCAS Targets with other Tracks (R3.179, R3.180, R3.181, R3.182)****2.2.3.3 Track Termination****2.2.3.4 Best Track Selection (R3.175)****2.2.3.4.1 For Applications****2.2.3.4.1.1 Choice between Sources (Joel's input for choosing between track sources)****2.2.3.4.1.2 Application Appropriateness (Tabel 2-3) – note: implementation in Surveillance Processing or Application Processing should be up to the vendor****2.2.3.4.2 For Display****2.2.3.4.2.1 Minimum # of Tracks (issue paper needed)****2.2.3.4.2.2 Track Selection Priority (issue paper needed)****2.2.4 Applications Processing****2.2.4.1 Input/Output List****2.2.4.2 General Requirements****2.2.4.2.1 Determination of Track Relative Horizontal Position (R3.190) - what about relative vertical position?****2.2.4.2.2 Extrapolation of position to common reference time for display (R3.186, R3.187, R3.188) - For application, do we separately extrapolate track state to common reference time?**

2.2.4.2.3 Determination of own-ship source selection (is a “should” right above R2.27 in ASA MASPS)

2.2.4.2.4 Forwarding of other parameters (R3.203 – R3.209)

2.2.4.2.5 ASSAP output interfaces (R3.213)

2.2.4.2.6 ASSAP Performance Requirements (R3.210 – R3.212)

2.2.4.3 Application-Specific Requirements

2.2.4.3.1 Determination of supported applications (R2.27, R2.29, R3.191, R3.192, R3.195, R3.196, R3.197, R3.198, R3.199)

2.2.4.3.2 Determination of conflict alert (R3.200, R3.201, R3.202)

2.2.4.3.3 Determination of degraded target conditions (R3.193)

2.2.4.3.4 Determination of selected target closure rate (R3.194)

2.3 Cockpit Display of Traffic Information (CDTI) Subsystem Requirements -- Rathinam

2.4 Equipment Performance – Environmental Conditions

The environmental tests and performance requirements described in this subsection are intended to provide a laboratory means of determining the overall performance characteristics of the equipment under conditions representative of those that may be encountered in actual aeronautical operation.

Unless otherwise specified, the test procedures applicable to a determination of equipment performance under environmental test conditions are contained in RTCA Document No. DO-160D, *Environmental Conditions and Test Procedures for Airborne Equipment*. General information on the use of RTCA/DO-160D is contained in Sections 1 through 3 of that document. Also, a method of identifying which environmental tests were conducted and other amplifying information on the conduct of the tests is contained in Appendix A of RTCA/DO-160D.

Some of the performance requirements in Subsection 2.2 are not required to be tested to all of the conditions contained in RTCA/DO-160D. Judgement and experience have indicated that these particular parameters are not susceptible to certain environmental conditions and that the level of performance specified in Subsection 2.2 will not be measurably degraded by exposure to these conditions.

In addition to the exceptions above, certain environmental tests contained in this subsection are not required for minimum performance equipment unless the manufacturer wishes to qualify the equipment for additional environmental conditions. If the manufacturer wishes to qualify the equipment to these additional conditions, then these tests shall be performed.

Use only those tests listed below that are necessary to assure proper operation in the aeronautical environments envisioned by the Committee. Paragraph 1.0 of RTCA/DO-160D provides additional information on this subject.

2.4.1 General Requirements**2.4.2 ASSAP Subsystem****2.4.3 CDTI Subsystem****2.5 Equipment Test Procedures****2.5.1 General Test Requirements****2.5.2 ASSAP Subsystem Test Requirements****2.5.3 CDTI Subsystem Test Requirements****3 INSTALLED EQUIPMENT PERFORMANCE**

This section states the minimum acceptable level of performance for the equipment when installed in the aircraft. For the most part, installed performance requirements are the same as those contained in Section 2, which were verified through bench and environmental test. However, certain requirements may be affected by the physical installation (e.g., antenna patterns, receiver sensitivity, etc.) and can only be verified after installation. The installed performance limits stated below take in consideration these situations.

3.1 Equipment Installation**3.1.1 Accessibility**

Controls and monitors provided for in-flight operations shall be readily accessible from the pilot's normal seated position. The appropriate operator/crew member(s) shall have an unobstructed view of displayed data when in the normal seated position.

3.1.2 Aircraft Environment

Equipment shall be compatible with the environmental condition present in the specific location in the aircraft where the equipment is installed.

3.1.3 Display Visibility

Display intensity shall be suitable for data interpretation under all cockpit ambient light conditions ranging from total darkness to reflected sunlight.

Note: *Visors, glare-shields or filters may be an acceptable means of obtaining daylight visibility.*

3.1.4 Dynamic Range

Operation of the equipment shall not be adversely affected by aircraft maneuvering or changes in attitude encountered in normal flight conditions.

3.1.5 Failure Protection

Any probable failure of the equipment shall not degrade the normal operation of equipment or systems connected to it. Likewise, the failure of interfaced equipment or systems shall not degrade normal operation of this equipment.

3.1.6 Interference Effects

The equipment shall not be the source of harmful conducted or radiated interference nor be adversely affected by conducted or radiated interference from other equipment or systems installed in the aircraft.

Note: *Electromagnetic compatibility problems noted after installation of this equipment may result from such factors as the design characteristics of previously installed systems or equipment and the physical installation itself. It is not intended that the equipment manufacturer design for all installation environments. The installing facility will be responsible for resolving any incompatibility between this equipment and previously installed equipment in the aircraft. The various factors contributing to the incompatibility shall be considered.*

3.1.7 Inadvertent Turnoff

Appropriate protection shall be provided to avert the inadvertent turnoff of the equipment.

3.1.8 Aircraft Power Source

State any requirements for connecting the equipment to the aircraft power source(s) to assure the equipment will perform its intended function(s) in the operational environment.

3.1.9 Other Requirements

Continue with other requirements concerning equipment installation items such as antenna, etc.

3.2 Installed Equipment Performance Requirements

The installed equipment shall meet the requirements of Subsections 2.1 and 2.2 in addition to, or as modified by, the requirements stated below.

State the requirements that the equipment must meet when installed in the aircraft. The following guidelines, although not all inclusive, serve to illustrate some of the more important aspects that should be considered:

- a. *Requirements should be strictly limited to those that the Committee considers necessary for all applications and user classes.*
- b. *In general, use one paragraph to express a single requirement.*
- c. *Requirements should be expressed in a manner that does not constrain design innovation.*

- d. *Requirements should not place undue constraints on installation flexibility.*
- e. *Care should be taken to define requirements that may be at variance with those stated in Section 2 because of physical or other installation constraints.*
- f. *State those requirements that the equipment must meet to perform its intended function(s) but can only be verified after installation.*
- g. *Unless a requirement can be verified solely through visual inspection, it should be expressed in measurable terms.*
- h. *Particular care must be taken to assure that the requirement statement is compatible with test procedures to be developed for paragraph 3.4.*

3.3 Conditions of Test

The following subparagraphs define conditions under which tests, specified in paragraph 3.4, shall be conducted.

3.3.1 Safety Precautions

State any personnel and/or equipment safety precautions that should be observed because of any unique characteristics of the equipment or installation.

3.3.2 Power Input

Unless otherwise specified, all aircraft electrically operated equipment and systems shall be turned ON before conducting interference testing.

3.3.3 Environment

During testing, the equipment shall not be subjected to environmental conditions that exceed those specified by the equipment manufacturer.

3.3.4 Adjustment of Equipment

Circuits of the equipment under test shall be properly aligned and otherwise adjusted in accordance with the manufacturer's recommended practices prior to application of the specified tests.

3.3.5 Warm-up Period

Unless otherwise specified, tests shall be conducted after a warm-up (stabilization) period of not more than fifteen (15) minutes.

3.3.6 Continue with Other Conditions as Necessary

3.4 Test Procedures for Installed Equipment Performance

The following test procedures provide one means of determining installed equipment performance. Although specific test procedures are cited, it is recognized that other methods may be preferred by the installing activity. These alternate procedures may be

used if they provide at least equivalent information. In such cases, the procedures cited herein should be used as one criterion in evaluating the acceptability of the alternate procedures. The equipment shall be tested to determine compliance with the minimum requirements stated in Subsection 2.2. In order to meet this requirement, test results supplied by the equipment manufacturer or other proof of conformity may be accepted in lieu of bench tests performed by the installing activity.

3.4.1 Ground Test Procedures

3.4.1.1 Conformity Inspection

Visually inspect the installed equipment to determine the use of acceptable workmanship and engineering practices. Verify that proper mechanical and electrical connections have been made and that the equipment has been located and installed in accordance with the manufacturer's recommendations.

3.4.1.2 Equipment Function

Vary all controls of the equipment through their full range to determine that the equipment is operating according to the manufacturer's instruction and that each control performs its intended function.

3.4.1.3 Interference Effects

With the equipment energized, individually operate each of the other electrically operated aircraft equipment and systems to determine that significant conducted or radiated interference does not exist. Evaluate all reasonable combinations of control settings and operating modes. Operate communication and navigation equipment on the low, high and at least on, but preferably four, mid-band frequencies. Make note of system or modes of operation that should also be evaluated during flight. If appropriate, repeat tests using emergency power with the aircraft's batteries alone and the inverters operating.

3.4.1.4 Power Supply Fluctuations

Under normal aircraft conditions, cycle the aircraft engine(s) through all normal power settings and verify proper operation of the equipment as specified by the equipment manufacturer.

3.4.1.5 Equipment Accessibility

Determine that all equipment controls and displayed data are readily accessible and easily interpreted.

3.4.1.6 Continue with Other Test Procedures

Continue with other test procedures to verify those installed performance requirements of paragraphs 3.1 and 3.2 that can be demonstrated with the aircraft on the ground.

3.4.2 Flight Test Procedures

3.4.2.1 Displayed Data Readability

Determine that normal conditions of flight do not significantly affect the readability of displayed data.

3.4.2.2 Interference Effects

For aircraft equipment and systems that can be checked only in flight, determine that operationally significant conducted or radiated interference does not exist. Evaluate all reasonable combinations of control settings and operating modes. Operate communications and navigation equipment on the low, high and at least one, but preferable four, mid-band frequencies.

3.4.2.3 Continue with Other Test Procedures

Continue with other test procedures to verify those installed performance requirements of paragraphs 3.1 and 3.2 that can only, or more conveniently, be demonstrated in flight. Certain cases such as navigation performance, airborne coverage, etc., may require that the aircraft fly paths having specific characteristics. These essential characteristics, including typical flight test paths, should be included together with suggested data acquisition and analysis methods.

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4 EQUIPMENT OPERATIONAL PERFORMANCE CHARACTERISTICS

4.1 Required Operational Performance Requirements

To ensure the operator that operations can be conducted safely and reliably in the expected operational environment, there are specific minimum acceptable performance requirements that shall be met. The following paragraphs identify these requirements.

4.1.1 Power Inputs

Prior to flight, verify that the equipment is receiving primary input power necessary for proper conditions.

4.1.2 Equipment Operating Modes

The equipment shall operate in each of its operating modes.

4.1.3 Continue with Other Operational Requirements as Necessary

4.2 Test Procedures for Operational Performance Requirements

Operation equipment tests may be conducted as part of normal pre-flight tests. For those tests that can only be run in flight, procedures should be developed to perform these tests as early during the flight as possible to verify that the equipment is performing its intended function(s).

4.2.1 Power Input

With the aircraft's electrical power generating system operating, energize the equipment and verify that electrical power is available to the equipment.

4.2.2 Equipment Operating Modes

Verify that the equipment performs its intended function(s) for each of the operating modes available to the operator.

4.2.3 Continue with Other Test Procedures

Continue with other test procedures to verify the requirements of paragraph 4.1.

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